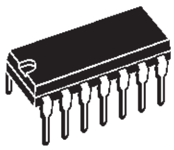
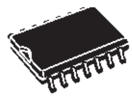
LM723

HIGH PRECISION VOLTAGE REGULATOR

- INPUT VOLTAGE UP TO 40V
- OUTPUT VOLTAGE ADJUSTABLE FROM 2 TO 37V
- POSITIVE OR NEGATIVE SUPPLY OPERATION
- SERIES, SHUNT, SWITCHING OR FLOATING OPERATION
- OUTPUT CURRENT TO 150mA WITHOUT EXTERNAL PASS TRANSISTOR
- ADJUSTABLE CURRENT LIMITING



Plastic DIP-14

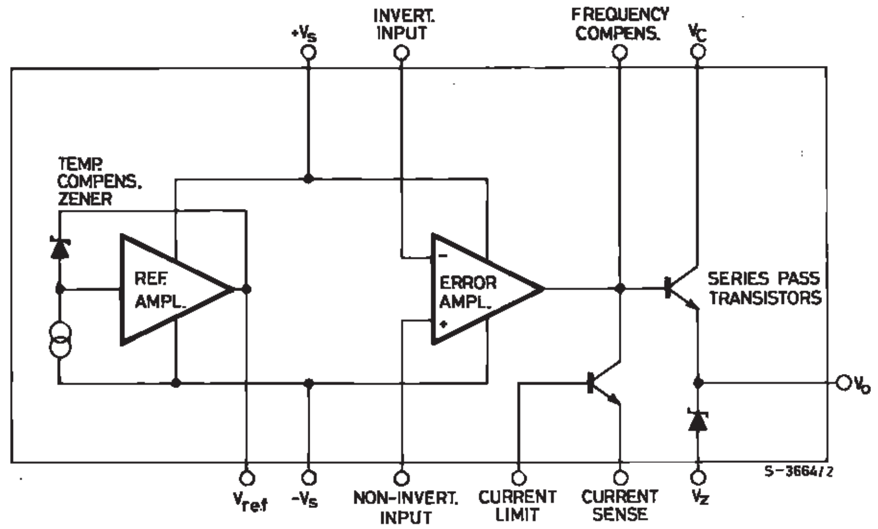


SO-14

DESCRIPTION

The LM723 is a monolithic integrated programmable voltage regulator, assembled in 14-lead dual in-line plastic and SO-14 micropackage. The circuit provides internal current limiting. When the output current excedes 150mA an external NPN or PNP pass element may be used. Provisions are made for adjustable current limiting and remote shut-down.

BLOCK DIAGRAM



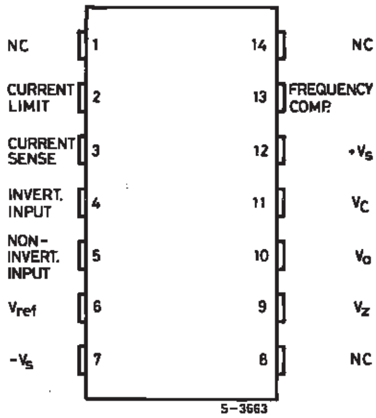
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value		Unit
		LM723	LM723C	
V_i	DC Input Voltage	40	40	V
ΔV_{i-o}	Dropout Voltage	40	40	V
I_o	Output Current	150	150	mA
I_{ref}	Current from V_{ref}	15	25	mA
T_{op}	Operating Temperature	-55 to 125	0 to 70	^oC
T_{stg}	Storage Temperature	-65 to 150	-65 to 150	^oC
T_j	Junction Temperature	150	125	^oC

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Plastic DIP-14	SO-14	Unit
$R_{thj-amb}$	Thermal Resistance Junction-Ambient Max	200	160	$^oC/W$

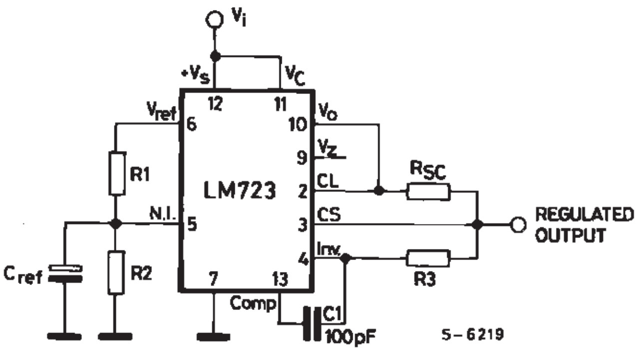
PIN CONNECTION (top views)



ORDER CODES

Type	Plastic DIP-14	SO-14
LM723 LM723C	LM723N LM723CN	LM723CD

TEST CIRCUIT (pin configuration relative to the plastic package)



$V_i = 12V$
$V_o = 5V$
$I_o = 1mA$
$R_1/R_2 \leq 10K\Omega$

ELECTRICAL CHARACTERISTICS FOR LM723 (refer to the test circuits, T_{amb} = 25 °C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$\Delta V_o/\Delta V_i$	Line Regulation	V_i = 12 to 15V V_i = 12 to 40V V_i = 12 to 15V -55°C ≤ T_{amb} ≤ 125°C		0.01 0.02	0.1 0.2 0.3	% % %
$\Delta V_o/V_o$	Load Regulation	I_o = 1 to 50 mA I_o = 1 to 10 mA -55°C ≤ T_{amb} ≤ 125°C		0.03	0.15 0.6	% %
V_{REF}	Reference Voltage	I_{ref} = 160 µA	6.95	7.15	7.35	V
SVR	Supply Voltage Rejection	f = 100 Hz to 10 KHz C_{ref} = 0 f = 100 Hz to 10 KHz C_{ref} = 5 µF		74 86		dB dB
$\Delta V_o/\Delta T$	Output Voltage Drift				150	ppm/°C
I_{sc}	Output Current Limit	R_{sc} = 10Ω V_o = 0		65		mA
V_i	Input Voltage Range		9.5		40	V
V_o	Output Voltage Range		2		37	V
V_o-V_i			3		38	V
I_d	Quiescent Current	V_i = 30 V I_o = 0 mA		2.3	5	mA
K_{VH}	Long Term Stability			0.1		%/1000 hrs
e_N	Output Noise Voltage	BW = 100 Hz to 10 KHz C_{ref} = 0 BW = 100 Hz to 10 KHz C_{ref} = 5 µF		20 2.5		µV µV

ELECTRICAL CHARACTERISTICS FOR LM723C (refer to the test circuits, T_{amb} = 25 °C, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$\Delta V_o/\Delta V_i$	Line Regulation	V_i = 12 to 15V V_i = 12 to 40V V_i = 12 to 15V 0°C ≤ T_{amb} ≤ 70°C		0.01 0.1	0.1 0.5 0.3	% % %
$\Delta V_o/V_o$	Load Regulation	I_o = 1 to 50 mA I_o = 1 to 10 mA 0°C ≤ T_{amb} ≤ 70°C		0.03	0.2 0.6	% %
V_{REF}	Reference Voltage	I_{ref} = 160 µA	6.8	7.15	7.5	V
SVR	Supply Voltage Rejection	f = 100 Hz to 10 KHz C_{ref} = 0 f = 100 Hz to 10 KHz C_{ref} = 5 µF		74 86		dB dB
$\Delta V_o/\Delta T$	Output Voltage Drift				150	ppm/°C
I_{sc}	Output Current Limit	R_{sc} = 10Ω V_o = 0		65		mA
V_i	Input Voltage Range		9.5		40	V
V_o	Output Voltage Range		2		37	V
V_o-V_i			3		38	V
I_d	Quiescent Current	V_i = 30 V I_o = 0 mA		2.3	4	mA
K_{VH}	Long Term Stability			0.1		%/1000 hrs
e_N	Output Noise Voltage	BW = 100 Hz to 10 KHz C_{ref} = 0 BW = 100 Hz to 10 KHz C_{ref} = 5 µF		20 2.5		µV µV

Figure 1 : Maximum Output Current vs. Voltage Drop.

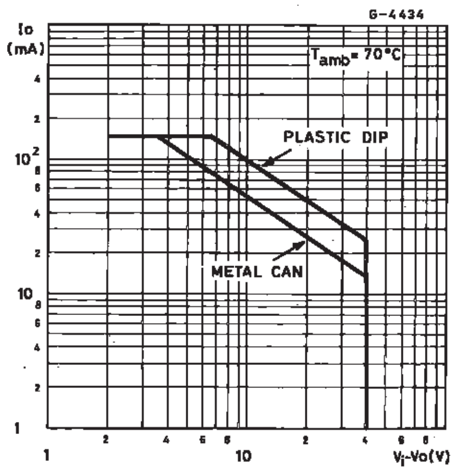


Figure 2 : Current Limiting Characteristics.

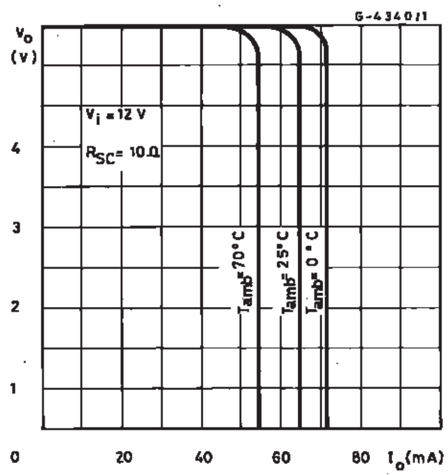


Figure 3 : Current Limiting Characteristics vs. Junction Temperature.

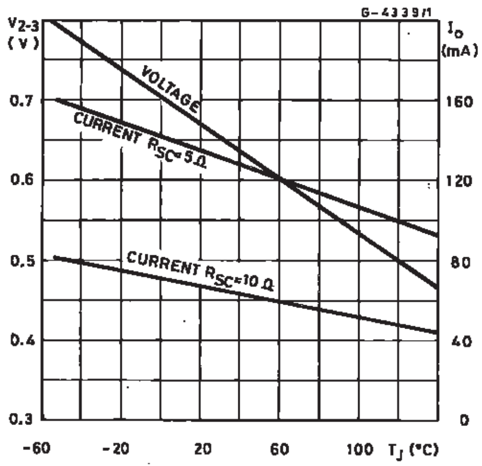


Figure 4 : Load Regulation Characteristics without Current Limiting.

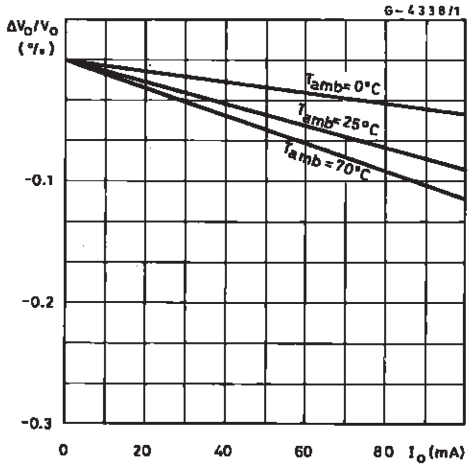


Figure 5 : Load Regulation Characteristics with Current Limiting.

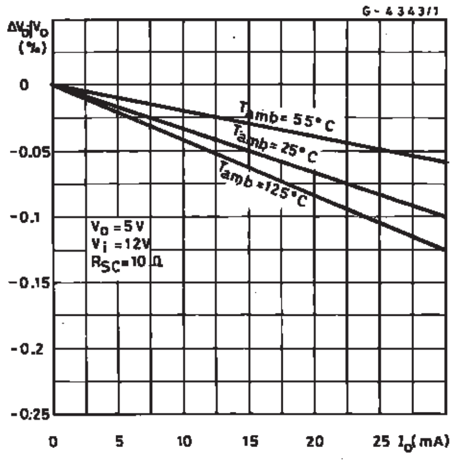


Figure 6 : Load Regulation Characteristics with Current Limiting

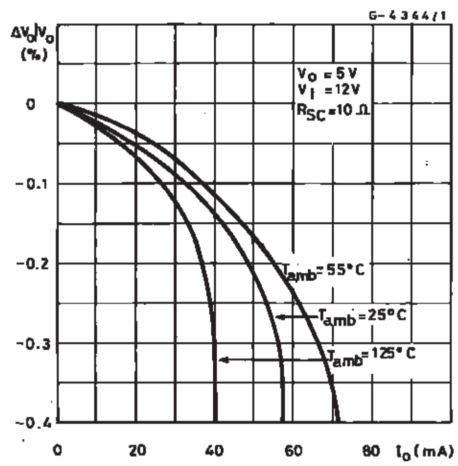


Figure 7 : Line Regulation vs. Voltage Drop.

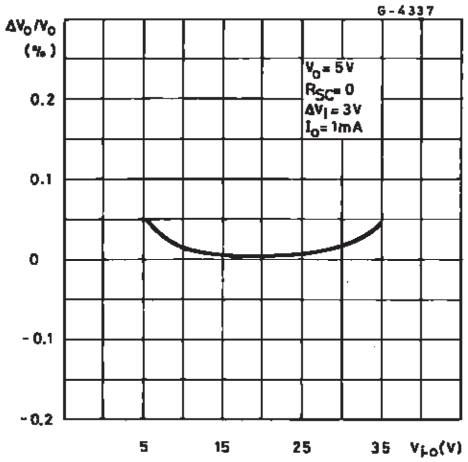


Figure 8 : Load Regulation vs. Voltage Drop.

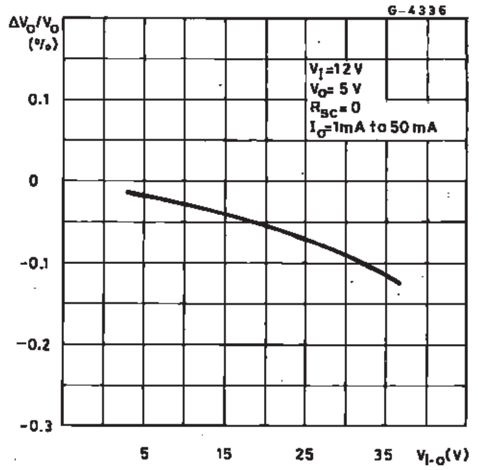


Figure 9 : Quiescent Drain Current vs. Input Voltage.

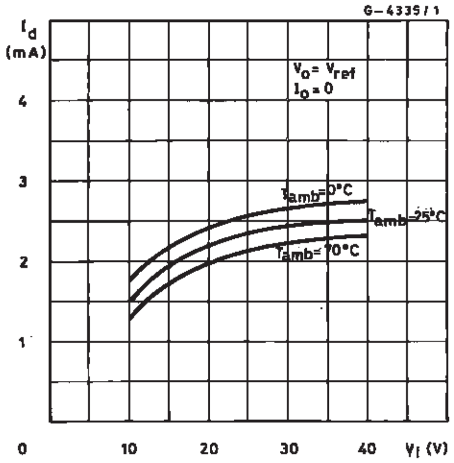


Figure 10 : Line Transient Response.

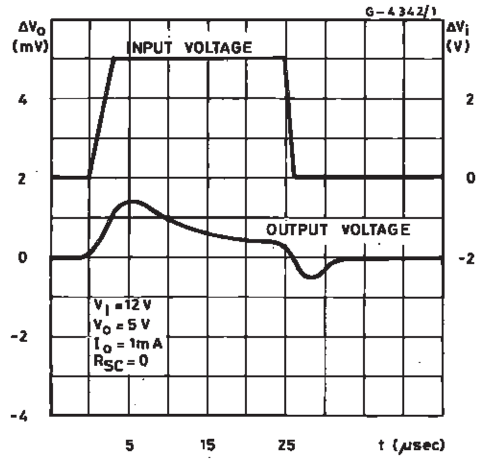


Figure 11 : Load Transient Response.

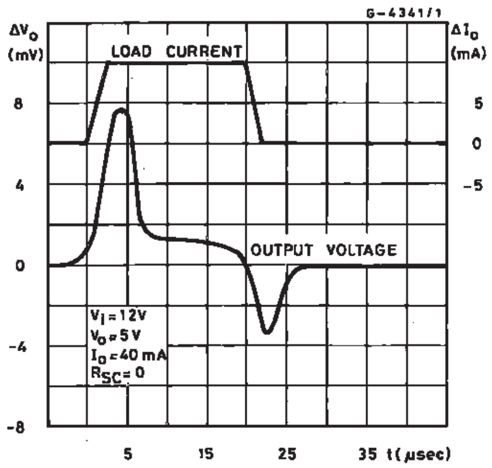


Figure 12 : Output Impedance vs. Frequency.

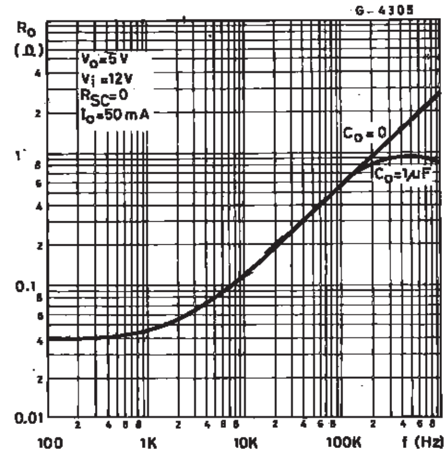


TABLE 1: Resistor Values (KΩ) for standard Output Voltages

Output Voltage	Applicable Figures	Fixed Output ± 5%		Output Adjustable ± 10% *		
		R1	R2	R1	P1	R2
+3	13, 16, 17, 18, 21, 23	4.12	3.01	1.8	0.5	1.2
+5	13, 16, 17, 18, 21, 23	2.15	4.99	0.75	0.5	2.2
+6	13, 16, 17, 18, 21, 23	1.15	6.04	0.5	0.5	2.7
+9	14, 16, 17, 18, 21, 23	1.87	7.15	0.75	1	2.7
+12	14, 16, 17, 18, 21, 23	4.87	7.15	2	1	3
+15	14, 16, 17, 18, 21, 23	7.87	7.15	3.3	1	3
+28	14, 16, 17, 18, 21, 23	21	7.15	5.6	1	2
+45	19	3.57	48.7	2.2	10	39
+75	19	3.57	78.7	2.2	10	68
+100	19	3.57	102	2.2	10	91
+250	19	3.57	255	2.2	10	240
-6**	15	3.57	2.43	1.2	0.5	0.75
-9	15	3.48	5.36	1.2	0.5	2
-12	15	3.57	8.45	1.2	0.5	3.3
-15	15	3.65	11.5	1.2	0.5	4.3
-28	15	3.57	24.3	1.2	0.5	10
-45	20	3.57	21.2	2.2	10	33
-100	20	3.57	97.6	2.2	10	91
-250	20	3.57	249	2.2	10	240

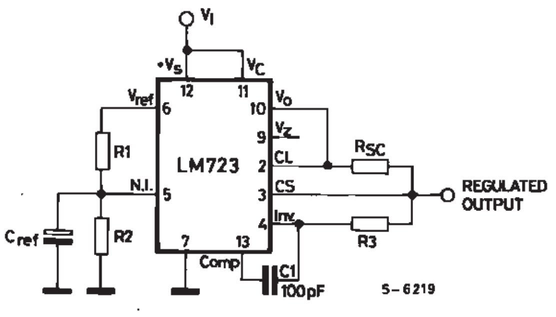
Note:
* Replace R1/R2 divider with the circuit of fig24.
** V+ must be connected to a +3V or greater supply.

TABLE 2: Formulae for Intermediate Output Voltages

Outputs from +2 to +7V Fig.13, 16, 17, 18, 21, 23 $V_O = [V_{ref} \times \frac{R_2}{R_1 + R_2}]$	Outputs from +4 to +250V Fig.19 $V_O = \left[\frac{V_{ref}}{2} \times \frac{R_2 - R_1}{R_1}\right]; R_3 = R_4$	Current Limiting $I_{LIMIT} = \frac{V_{SENSE}}{R_{sc}}$
Outputs from +7 to +37V Fig.14, 16, 17, 18, 21, 23 $V_O = [V_{ref} \times \frac{R_1 + R_2}{R_2}]$	Outputs from -6 to -250V Fig.15, 20 $V_O = \left[\frac{V_{ref}}{2} \times \frac{R_1 + R_2}{R_1}\right]; R_3 = R_4$	Foldback Current Limiting $I_{KNEE} = \left[\frac{V_O R_3}{R_{sc} R_4} \times \frac{V_{SENSE} (R_3 + R_4)}{R_{sc} R_4}\right]$ $I_{SHORT\ CKT} = \left[\frac{V_{SENSE}}{R_{sc}} \times \frac{R_3 + R_4}{R_4}\right]$

APPLICATION INFORMATION (pin numbers relative to the plastic package).

Figure 13 : Basic Low Voltage Regulator (V_o = 2 to 7V).

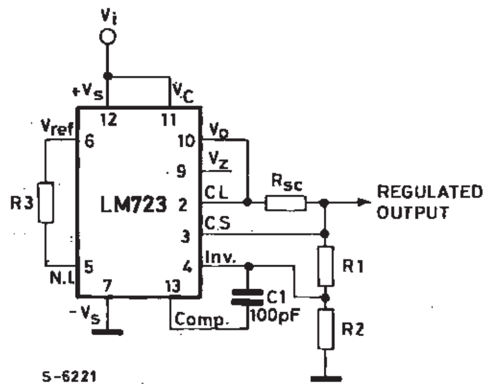


Note; $R_3 = \frac{R_1 \times R_2}{R_1 + R_2}$ for minimum temperature drift.
R3 may be eliminated for minimum component count.

Typical performance

Regulated Output Voltage...5V
Line Regulation (ΔV_i = 3V)..0.5mV
Load Regulation (ΔI_O = 50mA)..1.5mV

Figure 14 : Basic High Voltage Regulator (V_o = 7 to 37V).

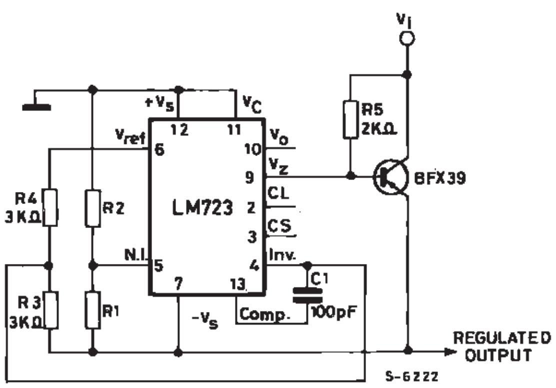


Note; $R_3 = \frac{R_1 \times R_2}{R_1 + R_2}$ for minimum temperature drift.
R3 may be eliminated for minimum component count.

Typical performance

Regulated Output Voltage...15V
Line Regulation (ΔV_i = 3V)..1.5mV
Load Regulation (ΔI_O = 50mA)..4.5mV

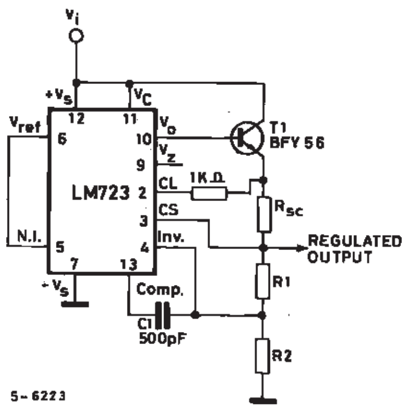
Figure 15 : Negative Voltage Regulator.



Typical performance

Regulated Output Voltage...15V
Line Regulation (ΔV_i = 3V)..1mV
Load Regulation (ΔI_O = 100mA)......................................2mV

Figure 16 : Positive Voltage Regulator (external

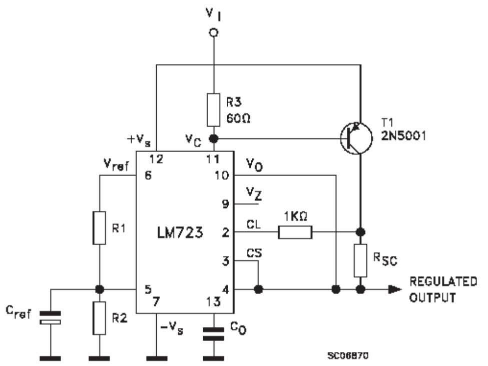


Typical performance

Regulated Output Voltage...+ 15V
Line Regulation (ΔV_i = 3V)..1.5mV
Load Regulation (ΔI_O = 1A)...15mV

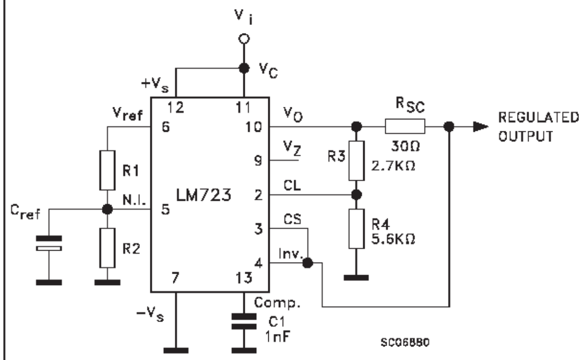
APPLICATION INFORMATION (continued).

Figure 17 : Positive Voltage Regulator (External PNP Pass Transistor)



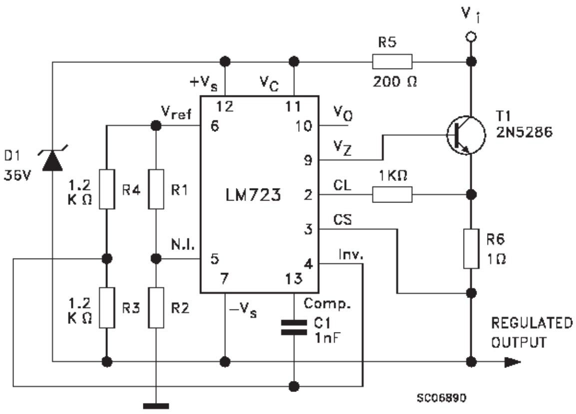
Typical performance
Regulated Output Voltage..5V
Line Regulation (ΔV_i = 3V)..0.5mV
Load Regulation (ΔI_O = 1 A)..1.5mV

Figure 18 : Foldback current limiting



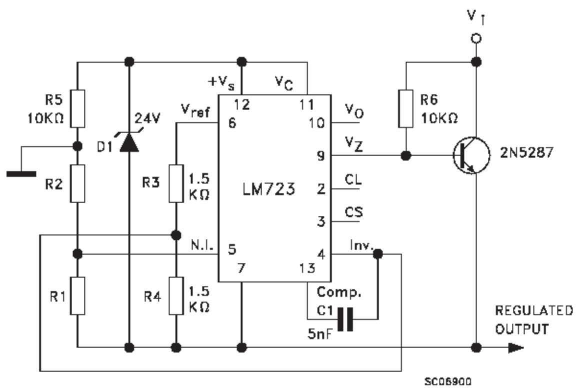
Typical performance
Regulated Output Voltage..5 V
Line Regulation (ΔV_i = 3V)..0.5mV
Load Regulation (ΔI_O = 10mA)..1mV
Current Limit Knee...20 mA

Figure 19 : Positive Floating Regulator



Typical performance
Regulated Output Voltage...100 V
Line Regulation (ΔV_i = 20V)..15 mV
Load Regulation (ΔI_O = 50mA).......................................20 mV

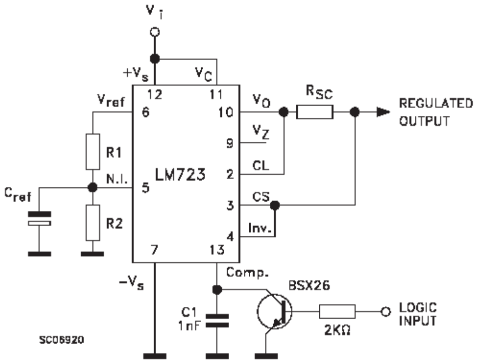
Figure 20 : Negative Floating Regulator



Typical performance
Regulated Output Voltage..- 100 V
Line Regulation (ΔV_i = 20V)..30 mV
Load Regulation (ΔI_O = 100 mA).......................................20 mV

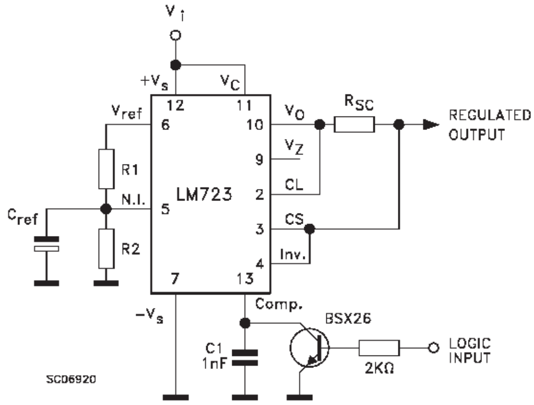
APPLICATION INFORMATION (continued).

Figure 21 : Positive Switching Regulator



Typical performance
Regulated Output Voltage..5 V
Line Regulation (ΔV_i = 30 V)...10 mV
Load Regulation (ΔI_O = 2 A)..80 mV

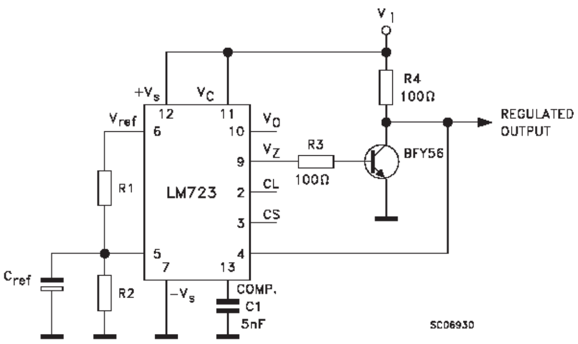
Figure 22 : Remote Shutdown Regulator With Current Limiting



Note: current limit transistor may be used for shutdown if current limiting is not required.

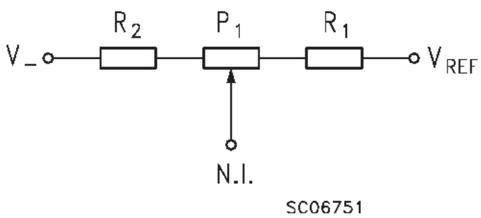
Typical performance
Regulated Output Voltage..5 V
Line Regulation (ΔV_i = 3 V)...0.5 mV
Load Regulation (ΔI_O = 50 mA)..1.5 mV

Figure 23 : Shunt Regulator.



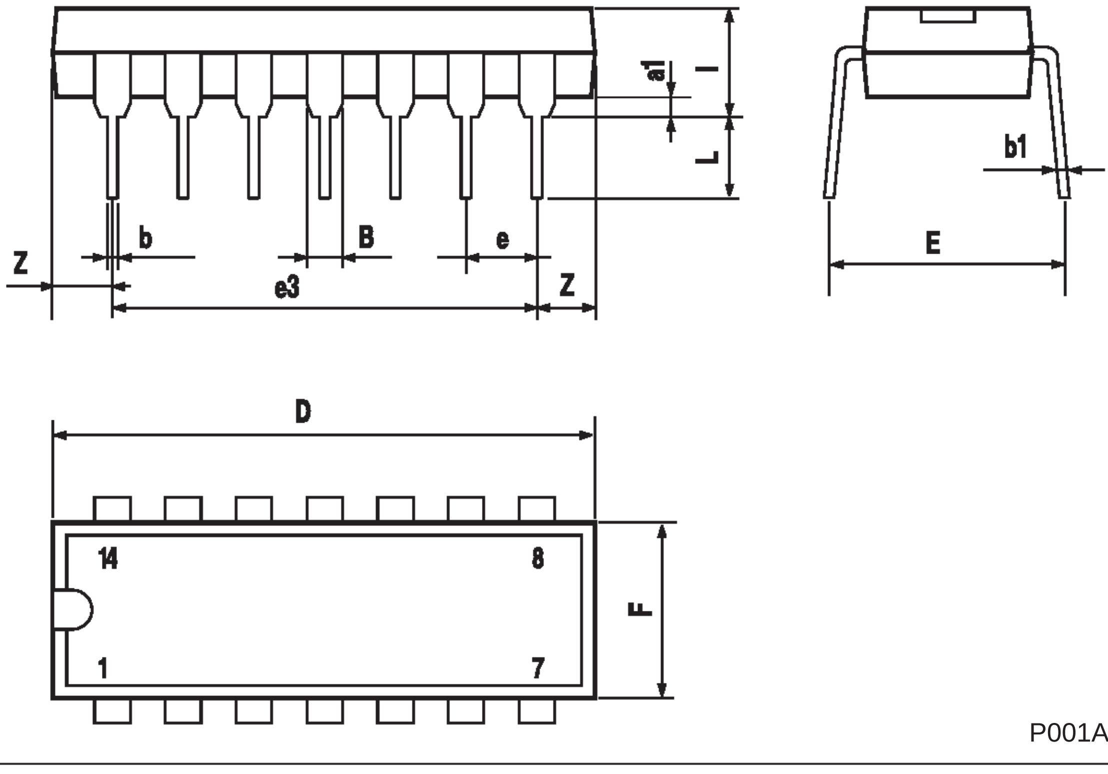
Typical performance
Regulated Output Voltage..5 V
Line Regulation (ΔV_i = 10 V)...2 mV
Load Regulation (ΔI_O = 100 mA)...5 mV

Figure 24 : Output Voltage Adjust



Plastic DIP-14 MECHANICAL DATA

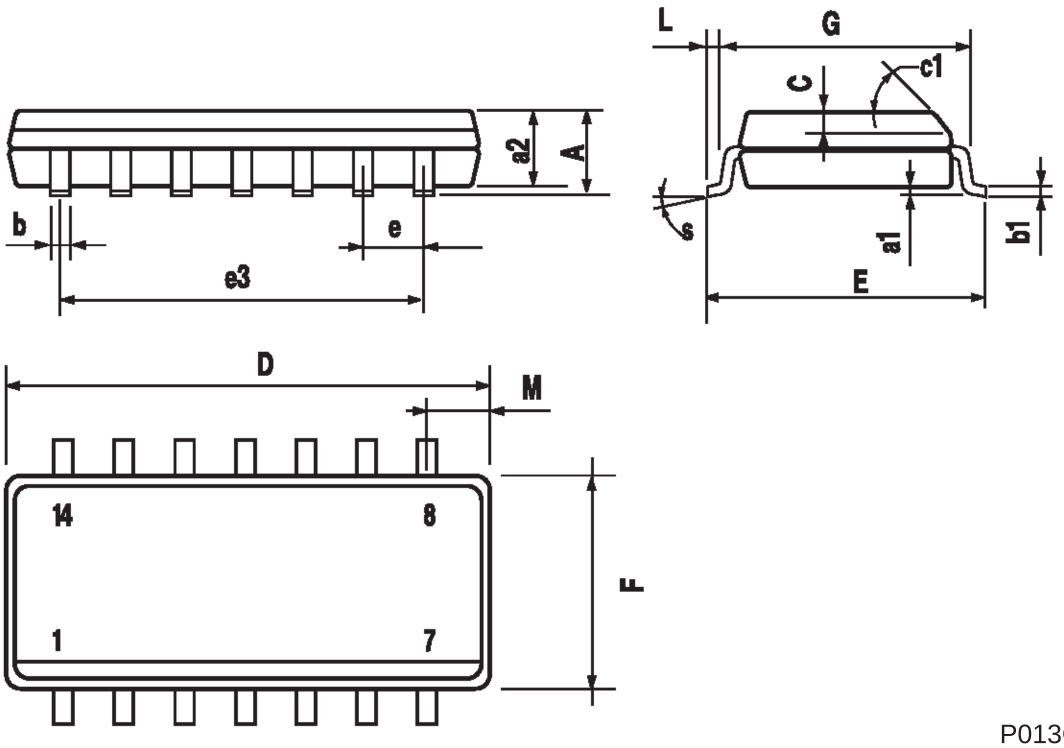
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



P001A

SO-14 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45 (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8 (max.)					



P013G